

Short communication

Chemical composition of the essential oil of *Salvia multicaulis* Vahl. var. *simplicifolia* Boiss. growing wild in Lebanon

Felice Senatore^{a,*}, Nelly Apostolides Arnold^b, Franco Piozzi^c

^a Dipartimento di Chimica delle Sostanze Naturali, Università degli Studi di Napoli "Federico II", Via D. Montesano 49, I-80131 Napoli, Italy

^b Faculté des Sciences Agronomiques, Université Saint Esprit, Kaslik (Beirut), Lebanon

^c Dipartimento di Chimica Organica, Università degli Studi di Palermo, Viale delle Scienze, Parco d'Orleans II, 90128 Palermo, Italy

Received 22 June 2004; accepted 11 August 2004

Abstract

The essential oil of aerial parts of *Salvia multicaulis* Vahl. var. *simplicifolia* Boiss. (Lamiaceae) growing wild in Lebanon was obtained by hydrodistillation and was analysed by GC and GC–MS. 67 compounds constituting 95.2% of the oil were identified, the major components being α -copaene (8.0%), α -pinene (6.6%), myrtenol (5.7%), *trans*-sabinyl acetate (5.3%).

© 2004 Elsevier B.V. All rights reserved.

Keywords: *Salvia multicaulis* Vahl. var. *simplicifolia* Boiss.; Lamiaceae; Essential oil composition; α -Copaene; α -Pinene; Myrtenol; *trans*-Sabinyl acetate

1. Introduction

The genus *Salvia* belongs to the Lamiaceae family (subfamily Nepetoideae), which is one of the most widely distributed around the world and comprises herbs and shrubs growing in the temperate and warmer zones of the world. Several plants of this genus are used as aromatic and ornamental plants or for their biological activities [1–6]. As a part of our research on the *Salvia* genus [5–7] in the present work we report on the chemical composition of the oil from the aerial parts of *Salvia multicaulis* Vahl. var. *simplicifolia* Boiss. (Lamiaceae) from Lebanon extracted by hydrodistillation and analysed by gas chromatography (GC) and gas chromatography coupled to mass spectrometry (GC–MS). *S. multicaulis* is an evergreen shrub growing to 0.3 m \times 0.25 m, native to South-West Asia, particular Eastern, Central and Southern Turkey. The aromatic leaves are quite similar to those of the common sage (*Salvia officinalis*) and a good substitute of them in cooking. The plant is in leaf all year, in flower from June to August. The plant is

used as a condiment for tea or is prepared as a tea in boiling water. Some of the components isolated from the extracts of *S. multicaulis* were diterpenoids [8], norditerpenoids [9] and triterpenoids [8], salvimultine [10], a noricetexane diterpene. The essential oil of *S. multicaulis* from plants grown in Iran as been also previously reported [11,12]. Bornyl acetate, β -caryophyllene and α -pinene were the major constituents of the flowering shoots [11], while the main constituents of the oil from leaves and flowers [12] were α -pinene, 1,8-cineole + limonene and camphor. As far we know, this is the first report about the analysis on a specimen from Lebanon.

2. Materials and methods

2.1. Plant material

Aerial parts of *S. multicaulis* Vahl. var. *simplicifolia* Boiss. were gathered at the full flowering stage from plants wild growing near Tannourine (Lebanon), 1700 msl, in April 2003. A voucher specimen (leg. and det. N. Arnold s.n., "confirm. Th. Raus) was deposited in the Herbarium of the Botanischer Garten, Berlin Universität.

* Corresponding author. Fax: +39 081 678552.

E-mail address: fesenato@unina.it (F. Senatore).

Table 1
Composition of the essential oil from *Salvia multicaulis* Vahl. var. *simplicifolia* Boiss. (Lamiaceae) growing wild in Lebanon

<i>f</i> ^a	<i>f</i> ^b	Compound	Identification ^c	Percentage ^d
938	1032	α-Pinene	<i>I</i> , MS, Co-GC	6.6
953	1076	Camphene	<i>I</i> , MS, Co-GC	1.1
973	1132	Sabinene	<i>I</i> , MS	0.2
980	1118	β-Pinene	<i>I</i> , MS, Co-GC	0.7
993	1174	Myrcene	<i>I</i> , MS	0.6
1025	1280	<i>P</i> -Cymene	<i>I</i> , MS	0.1
1030	1203	Limonene	<i>I</i> , MS, Co-GC	0.8
1034	1213	1,8-Cineole	<i>I</i> , MS, Co-GC	3.8
1105	1430	α-Thujone	<i>I</i> , MS	1.1
1115	1451	β-Thujone	<i>I</i> , MS	1.0
1137	1664	<i>trans</i> -Pinocarveol	<i>I</i> , MS	0.6
1145	1532	Camphor	<i>I</i> , MS, Co-GC	0.5
1167	1719	Borneol	<i>I</i> , MS, Co-GC	1.9
1176	1611	Terpinen-4-ol	<i>I</i> , MS, Co-GC	1.2
1183	1757	<i>cis</i> -Piperitol	<i>I</i> , MS	0.1
1193	1648	Myrtenal	<i>I</i> , MS	1.2
1196	1804	Myrtenol	<i>I</i> , MS	5.7
1217	1845	<i>trans</i> -Carveol	<i>I</i> , MS	0.4
1227		Myrtenyl acetate	<i>I</i> , MS	1.2
1284	1597	Bornyl acetate	<i>I</i> , MS, Co-GC	0.4
1293	2198	Thymol	<i>I</i> , MS, Co-GC	1.3
1295	1658	Sabinyl acetate	<i>I</i> , Ms	5.3
1299	2239	Carvacrol	<i>I</i> , MS, Co-GC	0.8
1333	1709	α-Terpinyl acetate	<i>I</i> , MS	0.4
1343	1748	Piperitone	<i>I</i> , MS	0.8
1352	1466	α-Cubebene	<i>I</i> , MS	0.1
1353	2186	Eugenol	<i>I</i> , MS, Co-GC	2.0
1363	1492	Cyclosativene	<i>I</i> , MS	<i>t</i>
1372	1493	Ylangene	<i>I</i> , MS	0.8
1377	1497	α-Copaene	<i>I</i> , MS	8.0
1385	1535	β-Bourbonene	<i>I</i> , MS	1.1
1387	1600	β-Elementene	<i>I</i> , MS	<i>t</i>
1415	1612	β-Caryophyllene	<i>I</i> , MS, Co-GC	4.0
1437	1628	Aromadendrene	<i>I</i> , MS	4.6
1452	1673	(<i>E</i>)-β-Farnesene	<i>I</i> , MS	0.7
1455	1689	α-Humulene	<i>I</i> , MS	0.3
1463	1661	<i>allo</i> -Aromadendrene	<i>I</i> , MS	1.7
1475	1715	β-Selinene	<i>I</i> , MS	0.8
1477	1726	Germacrene D	<i>I</i> , MS	0.1
1478	1704	γ-Murolene	<i>I</i> , MS	2.5
1483	1784	<i>ar</i> -Curcumene	<i>I</i> , MS	1.4
1491		Viridiflorene	<i>I</i> , MS	0.9
1495	1740	Valencene	<i>I</i> , MS	1.0
1498	1744	α-Selinene	<i>I</i> , MS	<i>t</i>
1500	1740	α-Murolene	<i>I</i> , MS	1.2
1515	1776	γ-Cadinene	<i>I</i> , MS	3.7
1520	1839	1 <i>S</i> - <i>cis</i> -Calamenene	<i>I</i> , MS	1.9
1526	1773	δ-Cadinene	<i>I</i> , MS	2.0
1541	1941	α-Calacorene	<i>I</i> , MS	0.6
1565	2057	Ledol	<i>I</i> , MS	1.0
1566	2050	(<i>E</i>)-Nerolidol	<i>I</i> , MS	1.2
1580	2150	Spathulenol	<i>I</i> , MS	<i>t</i>
1585	2098	Globulol	<i>I</i> , MS	0.4
1591	2104	Viridiflorol	<i>I</i> , MS	1.7
1605	2011	Humulene epoxide II	<i>I</i> , MS	0.1
1629	2025	<i>epi</i> -Globulol	<i>I</i> , MS	0.6
1642	2209	T-Murolol	<i>I</i> , MS	0.5
1644	2080	Cubenol	<i>I</i> , MS	0.8
1649	2255	α-Cadinol	<i>I</i> , MS	1.0
1650	2257	β-Eudesmol	<i>I</i> , MS	0.4
1677	2256	Cadalene	<i>I</i> , MS	2.0
1835	2131	Hexahydrofarnesyl acetone	<i>I</i> , MS	1.0
1950	2622	Phytol	<i>I</i> , MS	0.8

Table 1 (Continued)

<i>I</i> ^a	<i>I</i> ^b	Compound	Identification ^c	Percentage ^d
1957	2931	Palmitic acid	<i>I</i> , MS, Co-GC	0.2
2500	2500	Pentacosane	<i>I</i> , MS	0.6
2700	2700	Heptacosane	<i>I</i> , MS	1.2
2900	2900	Nonacosane	<i>I</i> , MS	1.0
		Monoterpene hydrocarbons		10.1
		Oxygen containing monoterpenes		26.2
		Sesquiterpene hydrocarbons		42.4
		Oxygen containing sesquiterpenes		7.7
		Phenolic compounds		4.1
		Others		4.8
		Total identified		95.2

^a HP-5 MS column.

^b HP Innovax.

^c *I* is the retention index, MS = mass spectrum, Co-GC = co-injection with authentic compound; d: *t* = trace, less than 0.05%.

2.2. Essential oil isolation

The oil from air-dried and ground aerial parts of plants was isolated by hydrodistillation for 3 h, using a Clevenger-type apparatus according to the method recommended in the *European Pharmacopoeia* [13]. The oil was dried over anhydrous sodium sulphate and stored at +4 °C in the dark until tested and analysed. The sample yielded 0.3% of yellow pale oil (on a dry mass).

2.3. GC analysis

Analytical gas chromatography was carried out on a Perkin-Elmer Sigma-115 gas chromatograph fitted with a HP-5MS capillary column (30 m × 0.25 m), 0.25 μm thickness. Helium was the carrier gas (1 ml/min). Column temperature was initially kept at 40 °C for 5 min, then gradually increased to 250 °C at 2 °C/min rate, held for 15 min and finally raised to 270 °C at 10 °C/min. Diluted samples (1/100, v/v, in *n*-pentane) of 1.0 ml were injected, at 250 °C, manually and in the splitless mode Flame ionization detection (FID) was performed at 280 °C.

2.4. GC–MS analysis

GC–MS analysis was performed on a Hewlett-Packard 5890 A apparatus, fitted with a fused silica HP-1 column (30 m × 0.25 m), 0.33 μm film thickness coupled to a HP mass/selective detector (MSD 5970 HP); ionization voltage 70 eV; electron multiplier energy 2000 V. Gas chromatographic conditions were as given; transfer line temperature, 295 °C. Analysis was also run by using a fused silica HP Innovax polyethyleneglycol capillary column (50 m × 0.20 m), 0.20 μm film thickness. In both cases helium was used as carrier gas.

2.5. Qualitative and quantitative analyses

Most constituents were identified by gas chromatography by comparison of their GC retention indices (*I*) with those

of the literature [14–16] or with those of standards available in our laboratories. The retention indices were determined in relation to a homologous series of *n*-alkanes (C₈–C₂₄) under the same operating conditions. Further identification was made by comparison of their mass spectra on both columns with those stored in NIST 98 and Wiley 5 Libraries or with mass spectra from literature [14,16]. Component relative concentrations were calculated based on GC peak areas without using correction factors.

3. Results and discussion

Sixty-seven constituents, representing 95.2% of the total components in the oil, have been identified in the essential oil extracted from the aerial parts of *S. multicaulis* Vahl. var. *simplicifolia* Boiss.; their retention indices, percentage composition and identification methods are given in Table 1, where the components are listed in order of elution on the HP 5MS column. The sesquiterpene fraction amounts 50.1% of the oil while the monoterpene fraction was lower (36.3%). The principal components of the oil were identified as α-copaene (8.0%), α-pinene (6.6%), myrtenol (5.7%) and *trans*-sabinyl acetate (5.3%). Other minor constituents were found to be aromadendrene (4.6%) and 1,8-cineole (3.8%). The phenolic compounds amounted to 4.1% and eugenol (2.0%) was the major one. The sample studied by us is different from the other Iranian samples [11,12]. According to Ahmadi and Mirza [11], bornyl acetate (18.1%) and camphor (10.0%) were among the main components of *S. multicaulis*, whereas they were detected only in low amounts (0.4% and 0.5%, respectively) in the present study. The other Iranian sample [12] was characterized by high amounts of α-pinene (26.0%), 1,8-cineole + limonene (20%) and camphor (10.0%), which were present in our sample in lower concentrations. These differences might have been derived both from harvest time and local, climatic and seasonal factors or we may hypothesize that the Lebanese sample belongs to a different chemotype. However, further investigations are needed to elucidate this hypothesis.

Acknowledgment

The GC and GC–MS spectra were performed at the “C.R.A.S.” of the University “Federico II” Napoli. The assistance of the staff is gratefully appreciated.

References

- [1] C.A. Newall, L.A. Anderson, J.D. Phillipson, *Herbal Medicines: A Guide for Healthcare Professionals*, Pharmaceutical Press, London, 1996.
- [2] R.F. Weiss, *Herbal Medicine*, Beaconsfield Publishers, Beaconsfield, 1998.
- [3] T. Kusumi, T. Ooi, T. Hayashi, H. Kakisawa, *Phytochemistry* 9 (1985) 2118.
- [4] A. Peana, M. Satta, M.D.L. Moretti, M. Orecchioni, *Planta Med.* 60 (1994) 478.
- [5] F. Senatore, R. De Fusco, V. De Feo, *J. Essent. Oil Res.* 9 (1997) 151.
- [6] F. Senatore, V. De Feo, *J. Essent. Oil Res.* 10 (1998) 135.
- [7] F. Senatore, C. Formisano, N. Apostolides Arnold, F. Piozzi, *J. Essent. Oil Res.* (in press).
- [8] A. Ulubelen, N. Tan, U. Sonmez, G. Topcu, *Phytochemistry* 47 (1998) 899.
- [9] A. Ulubelen, G. Topcu, C.B. Johansson, *J. Nat. Prod.* 60 (1997) 1275.
- [10] A. Ulubelen, G. Topcu, *J. Nat. Prod.* 63 (2000) 879.
- [11] L. Ahmadi, M. Mirza, *J. Essent. Oil Res.* 11 (1999) 289.
- [12] A. Rustaiyan, S. Masoudi, A. Monfared, H. Komeilizadeh, *Flav. Fragr. J.* 14 (1999) 276.
- [13] *European Pharmacopoeia*, third ed., Council of Europe, Strasbourg, 1997, p. 121.
- [14] W. Jennings, T. Shibamoto, *Qualitative Analysis of Flavor and Fragrance Volatiles by Glass Capillary Gas Chromatography*, Academic Press, New York, 1980.
- [15] N.W. Davies, *J. Chromatogr.* 503 (1990) 1.
- [16] R.P. Adams, *Identification of Essential Oil Components by Gas Chromatography/Mass Spectroscopy*, Allured, Carol Stream, IL, 1995.